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(54) **COATING SYSTEM, COMPUTER-IMPLEMENTED METHOD FOR CONTROLLING A COATING SYSTEM AND COMPUTER PROGRAM PRODUCT**

BESCHICHTUNGSSYSTEM, COMPUTERGESTEUERTES VERFAHREN ZUR STEUERUNG EINES BESCHICHTUNGSSYSTEMS UND EIN COMPUTERPROGRAMM-PRODUKT

SYSTÈME DE REVÊTEMENT, PROCÉDÉ INFORMATIQUE DE CONTRÔLE D'UN SYSTÈME DE REVÊTEMENT ET UN PRODUIT DE PROGRAMME INFORMATIQUE

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**Description**

## FIELD OF THE INVENTION

**[0001]** The subject matter disclosed herein relates to fabrication of materials in turbomachinery. More particularly, the subject matter disclosed herein relates to coating components in turbomachinery.

## BACKGROUND OF THE INVENTION

**[0002]** A challenge in turbomachinery (e.g., gas turbomachines) manufacturing and maintenance is keeping component cooling holes free from obstruction, for example, when applying coating to turbomachine components. In particular, thermal spray coatings can block cooling holes in components, requiring costly, labor-intensive processes such as cutting using diamond-coated tools and/or carbide tools on a large number (e.g., tens or hundreds) of holes.

**[0003]** US 2009/226626 A1 discloses a method of applying a thermal barrier coating to a component, with concurrent cooling hole cleaning using projected particles. US2014/272104 discloses an analogous method.

## BRIEF DESCRIPTION OF THE INVENTION

**[0004]** The invention provides a system according to appended claim 1.

**[0005]** A second aspect of the invention concerns a computer-implemented method as defined in claim 8.

**[0006]** A third aspect of the invention concerns a computer program product as defined in claim 9.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0007]** These and other features of this disclosure will be more readily understood from the following detailed description of the various aspects of the disclosure taken in conjunction with the accompanying drawings that depict various embodiments of the disclosure, in which:

FIG. 1 shows a schematic depiction of an environment including a system according to various embodiments of the invention.

FIG. 2 shows a close-up schematic depiction of components of the system of FIG. 1.

FIG. 3 shows a close-up schematic depiction of manifold according to various embodiments of the invention.

**[0008]** It is noted that the drawings of the various aspects of the invention are not necessarily to scale. The drawings are intended to depict only typical aspects of the invention, and therefore should not be considered as limiting the scope of the invention. In the drawings, like numbering represents like elements between the drawings.

## DETAILED DESCRIPTION OF THE INVENTION

**[0009]** As indicated herein, the subject matter disclosed relates to fabrication of materials in turbomachinery. More particularly, the subject matter disclosed herein relates to selective thermal coating of components in turbomachines, e.g., using a thermal spray coating such as a thermal barrier coating (TBC).

**[0010]** As noted herein, applying thermal spray coatings can block cooling holes in components, requiring costly, labor-intensive processes such as cutting using diamond-coated tools and/or carbide tools on a large number (e.g., tens or hundreds) of holes. Conventional approaches for maintaining unobstructed cooling holes during thermal coating include forcing air or an inert gas through all cooling holes in a component during an entire coating process. While these conventional approaches may prevent closure of some cooling holes, the volume of air or inert gas, along with the extended exposure time, causes the component to cool undesirably. An over-cooled component is less able to bond with the thermal spray coating, creating a coating with a higher potential to degrade during use.

**[0011]** In contrast to conventional approaches, various aspects of the disclosure include systems and methods for selectively preventing obstruction of cooling holes in components during a thermal spraying process. In some cases, a control system is coupled with a coating robot, and detects instructions for coating particular sections of a component. In response to detecting instructions for coating a particular section of the component, control system initiates a flow of air through cooling holes in that section of the component in order to prevent those cooling holes from being obstructed by the thermal coating material (e.g., TBC). In some cases, the control system is coupled to an airflow system that includes a rotary air slip ring. During some coating processes, the component rotates on a turntable, dolly or other platform, while the coating robot remains stationary or moves only a limited number of degrees around the component. The rotary air slip ring in the systems disclosed herein can allow the component to completely rotate (and over-rotate, e.g., 360+ degrees) without tangling air supply lines. With complete freedom to rotate the component, the system can more efficiently coat that component, saving time and expense. Additionally, by selectively forcing air through cooling holes, the system can prevent over-cooling the component, thereby increasing the quality of the coating when compared with conventional approaches. In other coating processes, the component is placed or otherwise mounted on a platform, and a coating robot moves around the platform to apply a coating. It is understood that in still other coating processes, the component can be placed on a turntable, dolly or other platform, and can rotate a limited number of degrees, while coating robot is also configured to move about the component a limited number of degrees. In any case, the systems described herein can improve the process of

coating a component relative to conventional systems and approaches.

**[0012]** In the following description, reference is made to the accompanying drawings that form a part thereof, and in which is shown by way of illustration specific example embodiments in which the present teachings may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the present teachings and it is to be understood that other embodiments may be utilized and that changes may be made without departing from the scope of the present teachings. The following description is, therefore, merely illustrative.

**[0013]** FIG. 1 shows a schematic depiction of an environment including a system 2 according to various embodiments of the disclosure. As shown, system 2 includes a coating system 10 configured to apply a thermal coating material 12, e.g., a thermal barrier coating, to a component 14. In some cases, thermal barrier coating (TBC) can include a conventional TBC having multiple layers (e.g., four layers: metal substrate, metallic bond coat, thermally-grown oxide (TGO), and ceramic top-coat), but may include any other conventional thermal coating material 12 known in the art. FIG. 2 shows a close-up schematic depiction of coating system 10 along with an airflow system 20, further described herein. Coating system 10 can include a robotic coating system, including, e.g., an applicator and a material reservoir (or source line), as is known in the art. In some cases, coating system 10 includes at least one of a robot applicator, an aerosol printer an ink-jet printer or a manual spray system (e.g., operated by a human operator, and configured to send an indication that coating is applied to a particular portion of component 14, e.g., to control system 40).

**[0014]** Component 14 has a plurality of cooling holes 16, which includes distinct subsets of cooling holes 16A, 16B, etc., located in regions 18 of component 14. That is, subsets of cooling holes 16A, 16B, have distinct flow paths running therethrough, such that fluid flow through one subset of cooling holes 16A will not flow through a distinct subset of cooling holes 16B, etc. In some cases, cooling holes 16A located in one region, e.g., region 18A, may have a distinct geometry from cooling holes 16B in a distinct region, e.g., region 18B, such as where region 16A includes leading edge cooling holes versus mid-span cooling holes in region 16B. In some cases, component 14 can include a turbomachine component, which includes cooling holes 16 for allowing the flow of cooling fluid therethrough, e.g., during operation of a turbomachine employing the component 14. Component 14, in some cases, can include at least one of a turbomachine blade, nozzle, bucket, shroud, flange, and/or a combustion hardware component such as a liner, a can, a transition piece, a cover plate, etc.

**[0015]** Airflow system 20 is coupled (e.g., via wireless and/or hardwired means) with coating system 10, and is configured to force air (e.g., ambient air, treated air, or other treated gas) through component 14. As shown in

the schematic depiction of system 2 in FIG. 2, airflow system 20 is fluidly connected with component 14 such that airflow system 20 can initiate a flow of air through one or more regions 18 of component 14 to selectively flush one or more subsets of cooling holes 16A, 16B, etc.

**[0016]** System 2 further includes a control system (coating control system) 40 coupled (e.g., via wireless and/or hardwired means) with airflow system 20 and coating system 10, via a computer system 120 (also referred to as a computing device). Coating control system 40 is configured to control airflow system 20 to selectively force air through cooling holes 16. Coating control system 40 can include any conventional electrical and/or mechanical control systems, and in various embodiments, may include logic configured to provide instructions to airflow system 20 and/or coating system 10 according to particular inputs, as described herein. In various embodiments, coating control system 40 is configured to perform actions including:

A) Detect coating instructions 42 for coating system 10, where coating instructions 42 instruct coating system 10 to apply thermal coating material 12 to a subset 16A, 16B of the plurality of cooling holes 16. In some cases, coating instructions 42 can include data about characteristic(s) of component 14, and can include computer-aided design (CAD) data such as coordinate data, log data, model data (e.g., two-dimensional and/or three-dimensional model data), that coating control system 40 obtains from a data model (stored in CAD data) of component 14. Coating instructions 42 can also include data about types of thermal coating material 12 to be applied to cooling holes 16, angles at which coating system 10 should apply thermal coating material 12, application speed, flow rate, intensity, etc. In various embodiments, the characteristic of cooling holes 16 in component 8 can include at least one of a size of each of the plurality of cooling holes, a shape of each of the plurality of cooling holes, a type of each of the plurality of cooling holes or a location of each of the plurality of cooling holes (e.g., in regions 18A, 18B, etc.); and

B) In response to detecting coating instructions 42 (including selective coating of subset 16A, 16B, etc. of cooling holes 16), instruct airflow system 20, via selective airflow instructions 44 to force air through subset 16A, 16B of cooling holes 16 during application of thermal coating material 12 to the component 14. Airflow system 20 includes an air supply manifold 25 sized to engage with component and configured to selectively supply air through subsets 16A, 16B, etc. of cooling holes 16 during application of thermal coating material 12 to component 14. In some cases, air supply manifold 25 includes a series of fluid inlets 27 and outlets 29 for coupling with particular cooling holes 16 in component 14, as shown in the close-up schematic depiction of manifold 25 in FIG. 3. That

is, air supply manifold 25 includes independent cooling channels (including inlets 27 and outlets 29) which can be selectively engaged via one or more actuators 31, e.g., via dividing walls, valves, sliding partitions, etc. to fluidly couple with particular subsets 16A, 16B of cooling holes 16. Referring to FIGS. 1-3, in various embodiments, as discussed herein, control system 40 detects coating instructions 42 prior to application of thermal coating material 12 by coating system 10 in order to initiate the flow of air through select cooling holes 16 prior to coating. In various embodiments, airflow system 20 may selectively force air through the subset, e.g., 16A of cooling holes during one or more coating processes. That is, in some cases airflow system 20 may be configured to force air through only the subset, e.g., 16A of cooling holes during a coating process. For example, in some cases, component 14 can be coated in one or more stages, and one or more layers, of thermal coating material 12. In some cases, coating system 10 applies a metallic bondcoat, and (subsequently) a coating (e.g., thermal barrier coating (TBC)) to component 14 while airflow system 20 forces air through one or more subsets 16A, 16B, etc. of cooling holes 16. In the case that the thermal coating material 12 includes a TBC coating, the TBC can be blanket applied in some cases. It is understood, however, that the coating process may have several sub-processes. For example, a first coating process can include a bond coat, applied through air-plasma spray (APS) process or a high-velocity-oxygen-fuel (HVOF) process, or a combination of these processes. The following coating may include the TBC, applied using an APS process. According to various embodiments, the selective airflow instructions 44 used in each process can be distinct. For example, bond coat is a lower-temperature process that employs high-velocity particles (similar to grit blasting). TBC, on the other hand, is a relatively higher-temperature process. Using TBC may require a greater rate of airflow through one or more cooling holes than bond coat. It is understood that according to various embodiments, other coating processes may be employed, e.g., environmental barrier coating (EBC), in the case that component 14 includes a composite. In various embodiments, additional coating materials may be used, in the first coating process and/or the second coating process. For example, additional coating materials can include ceramic materials and/or ceramic-similar materials, such as aluminum-oxide, zirconium-oxide, hafnium-oxide, Yttria-stabilized zirconium-oxide and/or their derivatives. Additionally, coating materials can include graphite, as well as metallic materials such as cobalt-chromium-molybdenum. It is understood that according to various embodiments, prior the process of coating, an additional process can include grit blasting the exposed surfaces of component 14 to

achieve a desired surface roughness. These processes may be interposed between, or performed before/after processes described with reference to FIG. 1 and/or FIG. 2.

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**[0017]** In various embodiments, coating control system 40 is configured to instruct airflow system 20, via selective airflow instructions 44, to stop forcing air through subset 16A, 16B of cooling holes 16 after thermal coating material 12 has been applied to component 14. That is, after coating a particular region 18A, 18B, etc., or as a distinct region 18A, 18B, etc. of component is coated, airflow system 20 is instructed to stop forcing air through cooling holes 16 in the prior-coated region 18A, 18B, etc.

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**[0018]** Returning to FIG. 2, a schematic close-up view of airflow system 20 and coating system 10 is shown. In some embodiments, and in contrast to conventional systems, airflow system 20 can include a rotary air slip ring 50 for forcing air through component 14. Rotary air slip ring 50 is coupled to a feed line 52, and includes a rotating wheel 54 which rotates to pull ambient air through feed line 52, into a chamber 56, and up through outlet apertures 58 in a platform 60. In some cases, component 14 is placed on platform 60 and sealed, e.g., via a dressing or adhesive material such as tape, wrapping, etc., to outlet apertures 58 to allow airflow through component 14. In various embodiments, rotary air slip ring 50 permits the component 14 to rotate greater than 360 degrees about a primary axis ( $A_p$ ) of airflow system 20 without limiting airflow to component 14. That is, in various embodiments, coating system 10 includes a coating robot that is configured to remain stationary during application of the thermal coating material 12 (FIG. 1). In this sense, coating system 10 includes a base 70, and an applicator 72 for applying thermal coating material 12 to component 14. While applicator 72 may be movable across a variety of positions, in many cases, base 70 is designed to remain stationary during application of thermal coating material 12 to component 14. Using rotary air slip ring 50 permits component 14 to rotate, on platform 60, without limiting airflow to component 14. That is, in contrast to conventional systems, rotary air slip ring 50 does not include moving feed lines which can become tangled as a component 14 is rotated. The rotation of wheel 54 creates a vacuum within chamber 56, thereby pulling air through feed lines 52 for use in clearing cooling holes 16 in component 14 (via apertures 58). Because this vacuum is created regardless of the position of platform 60, rotary air slip ring 50 allows component 14 to be rotated one or more revolutions (as well as clockwise and counterclockwise) to more efficiently coat sections 18A, 18B, etc. of component 14.

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**[0019]** Returning to FIG. 1, computer system 120 is shown including a processing component 122 (e.g., one or more processors), a storage component 124 (e.g., a storage hierarchy), an input/output (I/O) component 126 (e.g., one or more I/O interfaces and/or devices), and a communications pathway 128. In one embodiment,

processing component 122 executes program code, such as coating control system 40, which is at least partially embodied in storage component 124. While executing program code, processing component 122 can process data, which can result in reading and/or writing the data to/from storage component 124 and/or I/O component 126 for further processing. Pathway 128 provides a communications link between each of the components in computer system 120. I/O component 126 can comprise one or more human I/O devices or storage devices, which enable a user 136 (e.g., human or machine user) to interact with computer system 120 and/or one or more communications devices to enable user 136 (e.g., human or machine user) to communicate with computer system 120 using any type of communications link. To this extent, coating control system 40 can manage a set of interfaces (e.g., graphical user interface(s), application program interface, and/or the like) that enable human and/or system interaction with coating control system 40.

**[0020]** In any event, computer system 120 can comprise one or more general purpose computing articles of manufacture (e.g., computing devices) capable of executing program code installed thereon. As used herein, it is understood that "program code" means any collection of instructions, in any language, code or notation, that cause a computing device having an information processing capability to perform a particular function either directly or after any combination of the following: (a) conversion to another language, code or notation; (b) reproduction in a different material form; and/or (c) decompression. To this extent, coating control system 40 can be embodied as any combination of system software and/or application software. In any event, the technical effect of computer system 120 is to selectively force air through cooling holes 16 during coating, based upon coating instructions 42 for a component 14.

**[0021]** Further, coating control system 40 can be implemented using a set of modules 132. In this case, a module 132 can enable computer system 20 to perform a set of tasks used by coating control system 40, and can be separately developed and/or implemented apart from other portions of coating control system 40. Coating control system 40 may include modules 132 which comprise a specific use machine/hardware and/or software. Regardless, it is understood that two or more modules, and/or systems may share some/all of their respective hardware and/or software. Further, it is understood that some of the functionality discussed herein may not be implemented or additional functionality may be included as part of computer system 120.

**[0022]** When computer system 120 comprises multiple computing devices, each computing device may have only a portion of coating control system 40 embodied thereon (e.g., one or more modules 132). However, it is understood that computer system 120 and coating control system 40 are only representative of various possible equivalent computer systems that may perform a process described herein. To this extent, in other embodiments,

the functionality provided by computer system 120 and coating control system 40 can be at least partially implemented by one or more computing devices that include any combination of general and/or specific purpose hardware with or without program code. In each embodiment, the hardware and program code, if included, can be created using standard engineering and programming techniques, respectively.

**[0023]** Regardless, when computer system 120 includes multiple computing devices, the computing devices can communicate over any type of communications link. Further, while performing a process described herein, computer system 120 can communicate with one or more other computer systems using any type of communications link. In either case, the communications link can comprise any combination of various types of wired and/or wireless links; comprise any combination of one or more types of networks; and/or utilize any combination of various types of transmission techniques and protocols.

**[0024]** As discussed herein, coating control system 40 enables computer system 120 to control coating of a (e.g., turbomachine) component 14. Coating control system 40 may include logic for performing one or more actions described herein. In one embodiment, coating control system 40 may include logic to perform the above-stated functions. Structurally, the logic may take any of a variety of forms such as a field programmable gate array (FPGA), a microprocessor, a digital signal processor, an application specific integrated circuit (ASIC) or any other specific use machine structure capable of carrying out the functions described herein. Logic may take any of a variety of forms, such as software and/or hardware. However, for illustrative purposes, coating control system 40 and logic included therein will be described herein as a specific use machine. As will be understood from the description, while logic is illustrated as including each of the above-stated functions, not all of the functions are necessary according to the teachings of the embodiments of the invention as recited in the appended claims.

**[0025]** In various embodiments, processes described herein can be iterated (repeated) periodically (e.g., according to schedule of x times per y period, and/or continuously) in order to aid in coating of one more portion(s) of one or more (turbomachine) component(s) 14. In some cases, one or more of the processes described herein can be repeated, for example, for a set of components 14 (e.g., turbomachine components).

**[0026]** It is understood that in the flow diagram shown and described herein, other processes may be performed while not being shown, and the order of processes can be rearranged according to various embodiments. Additionally, intermediate processes may be performed between one or more described processes. The flow of processes shown and described herein is not to be construed as limiting of the various embodiments.

**[0027]** This written description uses examples to disclose the invention, including the best mode, and also to

enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

## Claims

### 1. A system (2) comprising:

a coating system (10) configured to apply a thermal coating material (12) to a component (14), the component (14) having a plurality of cooling holes (16), wherein the plurality of cooling holes (16) includes a plurality of distinct subsets (16A, 16B) of cooling holes (16) located in a region (18) of the component (14), wherein fluid flow through a first distinct subset (16A) of cooling holes will not flow through a second distinct subset (16B) of cooling holes;

an airflow system (20) coupled with the coating system (10), the airflow system (20) configured to force air through the region (18) of the component (14) to selectively force air through one or more of the distinct subsets (16A, 16B) of cooling holes, wherein the airflow system (20) comprises an air supply manifold (25) including independent cooling channels selectively engageable via one or more actuators (31) with distinct subsets (16A, 16B) of cooling holes; and  
a control system (40) coupled with the airflow system (20) and the coating system (10), the control system (40) configured to:

detect coating instructions (42) for the coating system (10), and instruct the coating system (10) to apply the thermal coating material (12) to a subset (16A, 16B) of the plurality of cooling holes (16); and  
instruct the airflow system (20) to force air through only the subset (16A, 16B) of the plurality of cooling holes (16) during application of the thermal coating material (12) to the component (14) in response to detecting the coating instructions.

2. The system (2) of claim 1, wherein the airflow system (20) further includes a rotary air slip ring (50) for forcing the air through the component (14).

3. The system (2) of claim 2, wherein the rotary air slip

ring (50) permits the component (14) to rotate greater than 360 degrees about a primary axis of the airflow system (20) without limiting air flow to the component (14).

4. The system (2) of any one of claims 1 to 3, wherein the coating system (10) includes a coating robot.

5. The system (2) of claim 4, wherein the coating robot is configured to remain stationary during application of the thermal coating material (12).

6. The system (2) of any one of claims 1 to 5, wherein the thermal coating material (12) includes a thermal barrier coating (TBC).

7. The system (2) of any one of claims 1 to 6, wherein the control system (40) detects the coating instructions (42) prior to the application of the thermal coating material (12) by the coating system (10).

8. A computer-implemented method for controlling a coating system (10) configured to apply a thermal coating material (12) to a component (14) having a plurality of cooling holes (16), wherein the plurality of cooling holes (16) includes a plurality of distinct subsets (16A, 16B) of cooling holes (16) located in a region (18) of the component (14), wherein fluid flow through a first distinct subset (16A) of cooling holes will not flow through a second distinct subset (16B) of cooling holes, the method comprising:

detecting coating instructions (42) for the coating system (10), the coating instructions (42) instructing the coating system (10) to apply the thermal coating material (12) to a subset (16A, 16B) of the plurality of cooling holes (16); and  
instructing an airflow system (20) comprising an air supply manifold including independent cooling channels selectively engageable via one or more actuators (31) with distinct subsets (16A, 16B) of cooling holes and coupled with the component (14) to force air through only the subset (16A, 16B) of the plurality of cooling holes (16) during application of the thermal coating material (12) to the component (14) in response to detecting the coating instructions (42).

9. A computer program product comprising program code embodied in a computer readable storage medium, which when executed by at least one computing device, causes the at least one computing device to control a coating system (10) configured to apply a thermal coating material (12) to a component (14) having a plurality of cooling holes (16), wherein the plurality of cooling holes (16) includes a plurality of distinct subsets (16A, 16B) of cooling holes (16) located in a region (18) of the component (14), wherein

fluid flow through a first distinct subset (16A) of cooling holes will not flow through a second distinct subset (16B) of cooling holes, by performing actions including:

detecting coating instructions (42) for the coating system (10), the coating instructions (42) instructing the coating system (10) to apply the thermal coating material (12) to a subset (16A, 16B) of the plurality of cooling holes (16); and instructing an airflow system (20) comprising an air supply manifold including independent cooling channels selectively engagable via one or more actuators (31) with distinct subsets (16A, 16B) of cooling holes and coupled with the component to force air through only the subset (16A, 16B) of the plurality of cooling holes (16) during application of the thermal coating material (12) to the component (14) in response to detecting the coating instructions (42).

10. The computer program product of claim 9, wherein the coating system (10) includes a coating robot configured to execute the coating instructions (42).
11. The computer program product of any one of claims 9 to 10, wherein the at least one computing device detects the coating instructions (42) prior to the application of the thermal coating material (12) by the coating system (10).

#### Patentansprüche

1. System (2), umfassend:

ein Beschichtungssystem (10), das konfiguriert ist, um ein thermisches Beschichtungsmaterial (12) auf eine Komponente (14) aufzubringen, wobei die Komponente (14) eine Vielzahl von Kühllöchern (16) aufweist, wobei die Vielzahl von Kühllöchern (16) eine Vielzahl von eindeutigen Teilsätzen (16A, 16B) von Kühllöchern (16) einschließt, die sich in einer Region (18) der Komponente (14) befinden, wobei der Fluidstrom durch einen ersten eindeutigen Teilsatz (16A) von Kühllöchern nicht durch einen zweiten eindeutigen Teilsatz (16B) von Kühllöchern strömen wird;

ein Luftstromsystem (20), das mit dem Beschichtungssystem (10) gekoppelt ist, wobei das Luftstromsystem (20) konfiguriert ist, um Luft durch die Region (18) der Komponente (14) zu treiben, um Luft durch einen oder mehrere der eindeutige Teilsätze (16A, 16B) von Kühllöchern selektiv zu treiben, wobei das Luftstromsystem (20) einen Luftzufuhrverteiler (25) umfasst, einschließlich unabhängiger Kühlkanäle,

die über einen oder mehrere Aktuatoren (31) mit eindeutigen Teilsätzen (16A, 16B) von Kühllöchern selektiv in Eingriff gebracht werden können; und

ein Steuersystem (40), das mit dem Luftstromsystem (20) und dem Beschichtungssystem (10) gekoppelt ist, wobei das Steuersystem (40) konfiguriert ist zum:

Erfassen von Beschichtungsanweisungen (42) für das Beschichtungssystem (10) und Anweisen des Beschichtungssystems (10), das thermische Beschichtungsmaterial (12) auf einen Teilsatz (16A, 16B) der Vielzahl von Kühllöchern (16) aufzubringen; und Anweisen des Luftstromsystems (20), Luft nur durch den Teilsatz (16A, 16B) der Vielzahl von Kühllöchern (16) während des Aufbringens des thermischen Beschichtungsmaterials (12) auf die Komponente (14) als Reaktion auf das Erfassen der Beschichtungsanweisungen zu treiben.

2. System (2) nach Anspruch 1, wobei das Luftstromsystem (20) ferner einen Drehluftschleifring (50) zum Treiben der Luft durch die Komponente (14) einschließt.
3. System (2) nach Anspruch 2, wobei der Drehluftschleifring (50) ermöglicht, dass sich die Komponente (14) um mehr als 360 Grad um eine Hauptachse des Luftstromsystems (20) dreht, ohne den Luftstrom auf die Komponente (14) zu begrenzen.
4. System (2) nach einem der Ansprüche 1 bis 3, wobei das Beschichtungssystem (10) einen Beschichtungsroboter umfasst.
5. System (2) nach Anspruch 4, wobei der Beschichtungsroboter konfiguriert ist, um während des Aufbringens des thermischen Beschichtungsmaterials (12) stationär zu bleiben.
6. System (2) nach einem der Ansprüche 1 bis 5, wobei das thermische Beschichtungsmaterial (12) eine Hitzebarrierebeschichtung (TBC) einschließt.
7. System (2) nach einem der Ansprüche 1 bis 6, wobei das Steuersystem (40) die Beschichtungsanweisungen (42) vor dem Aufbringen des thermischen Beschichtungsmaterials (12) durch das Beschichtungssystem (10) erfasst.
8. Computerimplementiertes Verfahren zum Steuern eines Beschichtungssystems (10), das konfiguriert ist, um ein thermisches Beschichtungsmaterial (12) auf eine Komponente (14), die eine Vielzahl von Kühllöchern (16) aufweist, aufzubringen, wobei die

Vielzahl von Kühllöchern (16) eine Vielzahl von eindeutigen Teilsätzen (16A, 16B) von Kühllöchern (16) einschließt, die sich in einer Region (18) der Komponente (14) befinden, wobei der Fluidstrom durch einen ersten eindeutigen Teilsatz (16A) von Kühllöchern nicht durch einen zweiten eindeutigen Teilsatz (16B) von Kühllöchern strömen wird, das Verfahren umfassend:

Erfassen von Beschichtungsanweisungen (42) für das Beschichtungssystem (10), wobei die Beschichtungsanweisungen (42) das Beschichtungssystem (10) anweisen, das thermische Beschichtungsmaterial (12) auf einen Teilsatz (16A, 16B) der Vielzahl von Kühllöchern (16) aufzubringen, und

Anweisen eines Luftstromsystems (20), umfassend einen Luftzufuhrverteiler, einschließlich unabhängiger Kühlkanäle, die über einen oder mehrere Aktuatoren (31) mit eindeutigen Teilsätzen (16A, 16B) von Kühllöchern selektiv in Eingriff gebracht werden können, und mit der Komponente (14) gekoppelt sind, um Luft nur durch die Teilsätze (16A, 16B) der Vielzahl von Kühllöchern (16) während des Aufbringens des thermischen Beschichtungsmaterials (12) auf die Komponente (14) als Reaktion auf das Erfassen der Beschichtungsanweisungen (42) zu treiben.

9. Computerprogrammprodukt, umfassend einen Programmcode, der in einem computerlesbaren Speichermedium verkörpert ist, das, wenn es durch mindestens eine Rechenvorrichtung ausgeführt wird, veranlasst, dass die mindestens eine Rechenvorrichtung ein Beschichtungssystem (10) steuert, das konfiguriert ist, um ein thermisches Beschichtungsmaterial (12) auf eine Komponente (14), die eine Vielzahl von Kühllöchern (16) aufweist, aufzubringen, wobei die Vielzahl von Kühllöchern (16) eine Vielzahl von eindeutigen Teilsätzen (16A, 16B) von Kühllöchern (16) einschließt, die sich in einer Region (18) der Komponente (14) befinden, wobei der Fluidstrom durch einen ersten eindeutigen Teilsatz (16A) von Kühllöchern nicht durch einen zweiten eindeutigen Teilsatz (16B) von Kühllöchern strömen wird, durch Durchführen von Maßnahmen, die Folgendes einschließen:

Erfassen von Beschichtungsanweisungen (42) für das Beschichtungssystem (10), wobei die Beschichtungsanweisungen (42) das Beschichtungssystem (10) anweisen, das thermische Beschichtungsmaterial (12) auf einen Teilsatz (16A, 16B) der Vielzahl von Kühllöchern (16) aufzubringen, und

Anweisen eines Luftstromsystems (20), umfassend einen Luftzufuhrverteiler, einschließlich

unabhängiger Kühlkanäle, die über einen oder mehrere Aktuatoren (31) mit eindeutigen Teilsätzen (16A, 16B) von Kühllöchern selektiv in Eingriff gebracht werden können, und mit der Komponente gekoppelt sind, um Luft nur durch die Teilsätze (16A, 16B) der Vielzahl von Kühllöchern (16) während des Aufbringens des thermischen Beschichtungsmaterials (12) auf die Komponente (14) als Reaktion auf das Erfassen der Beschichtungsanweisungen (42) zu treiben.

10. Computerprogrammprodukt nach Anspruch 9, wobei das Beschichtungssystem (10) einen Beschichtungsroboter einschließt, der konfiguriert ist, um die Beschichtungsanweisungen (42) auszuführen.

11. Computerprogrammprodukt nach einem der Ansprüche 9 bis 10, wobei die mindestens eine Rechenvorrichtung die Beschichtungsanweisungen (42) vor dem Aufbringen des thermischen Beschichtungsmaterials (12) durch das Beschichtungssystem (10) erfasst.

## Revendications

1. Système (2) comprenant :

un système de revêtement (10) conçu pour appliquer un matériau de revêtement thermique (12) à un composant (14), le composant (14) ayant une pluralité de trous de refroidissement (16), dans lequel la pluralité de trous de refroidissement (16) comporte une pluralité de sous-ensembles distincts (16A, 16B) de trous de refroidissement (16) situés dans une région (18) du composant (14), dans lequel un écoulement de fluide à travers un premier sous-ensemble distinct (16A) de trous de refroidissement ne s'écoulera pas à travers un second sous-ensemble distinct (16B) de trous de refroidissement ;

un système d'écoulement d'air (20) accouplé au système de revêtement (10), le système d'écoulement d'air (20) étant conçu pour forcer l'air à travers la région (18) du composant (14) pour forcer sélectivement l'air à travers un ou plusieurs des sous-ensembles distincts (16A, 16B) de trous de refroidissement, dans lequel le système d'écoulement d'air (20) comprend un collecteur d'alimentation en air (25) comportant des canaux de refroidissement indépendants pouvant sélectivement être mis en prise par l'intermédiaire d'un ou plusieurs actionneurs (31) avec des sous-ensembles distincts (16A, 16B) de trous de refroidissement ; et

un système de commande (40) couplé au système d'écoulement d'air (20) et au système de

revêtement (10), le système de commande (40) étant configuré pour :

- détecter des instructions de revêtement (42) pour le système de revêtement (10), et donner instruction au système de revêtement (10) d'appliquer le matériau de revêtement thermique (12) à un sous-ensemble (16A, 16B) de la pluralité de trous de refroidissement (16) ; et  
donner instruction au système d'écoulement d'air (20) de forcer l'air à travers uniquement le sous-ensemble (16A, 16B) de la pluralité de trous de refroidissement (16) pendant une application du matériau de revêtement thermique (12) au composant (14) en réponse à la détection des instructions de revêtement.
2. Système (2) selon la revendication 1, dans lequel le système d'écoulement d'air (20) comporte en outre une bague collectrice d'air rotative (50) pour forcer l'air à travers le composant (14).
  3. Système (2) selon la revendication 2, dans lequel la bague collectrice d'air rotative (50) permet au composant (14) de tourner de plus de 360 degrés autour d'un axe primaire du système d'écoulement d'air (20) sans limiter l'écoulement d'air vers le composant (14).
  4. Système (2) selon l'une quelconque des revendications 1 à 3, dans lequel le système de revêtement (10) comporte un robot de revêtement.
  5. Système (2) selon la revendication 4, dans lequel le robot de revêtement est configuré pour rester stationnaire pendant l'application du matériau de revêtement thermique (12).
  6. Système (2) selon l'une quelconque des revendications 1 à 5, dans lequel le matériau de revêtement thermique (12) comporte un revêtement de barrière thermique (TBC).
  7. Système (2) selon l'une quelconque des revendications 1 à 6, dans lequel le système de commande (40) détecte les instructions de revêtement (42) avant l'application du matériau de revêtement thermique (12) par le système de revêtement (10).
  8. Procédé mis en oeuvre par ordinateur pour commander un système de revêtement (10) conçu pour appliquer un matériau de revêtement thermique (12) à un composant (14) ayant une pluralité de trous de refroidissement (16), dans lequel la pluralité de trous de refroidissement (16) comporte une pluralité de sous-ensembles distincts (16A, 16B) de trous de re-

froidissement (16) situés dans une région (18) du composant (14), dans lequel un écoulement de fluide à travers un premier sous-ensemble distinct (16A) de trous de refroidissement ne s'écoulera pas à travers un second sous-ensemble distinct (16B) de trous de refroidissement, le procédé comprenant :

la détection d'instructions de revêtement (42) pour le système de revêtement (10), les instructions de revêtement (42) donnant instruction au système de revêtement (10) d'appliquer le matériau de revêtement thermique (12) à un sous-ensemble (16A, 16B) de la pluralité de trous de refroidissement (16) ; et

le fait de donner instruction à un système d'écoulement d'air (20) comprenant un collecteur d'alimentation en air comportant des canaux de refroidissement indépendants pouvant sélectivement être mis en prise par l'intermédiaire d'un ou plusieurs actionneurs (31) avec des sous-ensembles distincts (16A, 16B) de trous de refroidissement et accouplés au composant (14) pour forcer l'air à travers uniquement le sous-ensemble (16A, 16B) de la pluralité de trous de refroidissement (16) pendant une application du matériau de revêtement thermique (12) au composant (14) en réponse à la détection des instructions de revêtement (42).

9. Produit programme informatique comprenant un code de programme incorporé dans un support de stockage lisible par ordinateur, qui lorsqu'il est exécuté par au moins un dispositif informatique, amène l'au moins un dispositif informatique à commander un système de revêtement (10) conçu pour appliquer un matériau de revêtement thermique (12) à un composant (14) ayant une pluralité de trous de refroidissement (16), dans lequel la pluralité de trous de refroidissement (16) comporte une pluralité de sous-ensembles distincts (16A, 16B) de trous de refroidissement (16) situés dans une région (18) du composant (14), dans lequel un écoulement de fluide à travers un premier sous-ensemble distinct (16A) de trous de refroidissement ne s'écoulera pas à travers un second sous-ensemble distinct (16B) de trous de refroidissement, en effectuant des actions comportant :

la détection d'instructions de revêtement (42) pour le système de revêtement (10), les instructions de revêtement (42) donnant instruction au système de revêtement (10) d'appliquer le matériau de revêtement thermique (12) à un sous-ensemble (16A, 16B) de la pluralité de trous de refroidissement (16) ; et

le fait de donner instruction à un système d'écoulement d'air (20) comprenant un collecteur d'alimentation en air comportant des ca-

naux de refroidissement indépendants pouvant sélectivement être mis en prise par l'intermédiaire d'un ou plusieurs actionneurs (31) avec des sous-ensembles distincts (16A, 16B) de trous de refroidissement et accouplés au composant pour forcer l'air à travers uniquement le sous-ensemble (16A, 16B) de la pluralité de trous de refroidissement (16) pendant une application du matériau de revêtement thermique (12) au composant (14) en réponse à la détection des instructions de revêtement (42).

10. Produit programme informatique selon la revendication 9, dans lequel le système de revêtement (10) comporte un robot de revêtement configuré pour exécuter les instructions de revêtement (42).
11. Produit programme informatique selon l'une quelconque des revendications 9 à 10, dans lequel l'au moins un dispositif informatique détecte les instructions de revêtement (42) avant l'application du matériau de revêtement thermique (12) par le système de revêtement (10).

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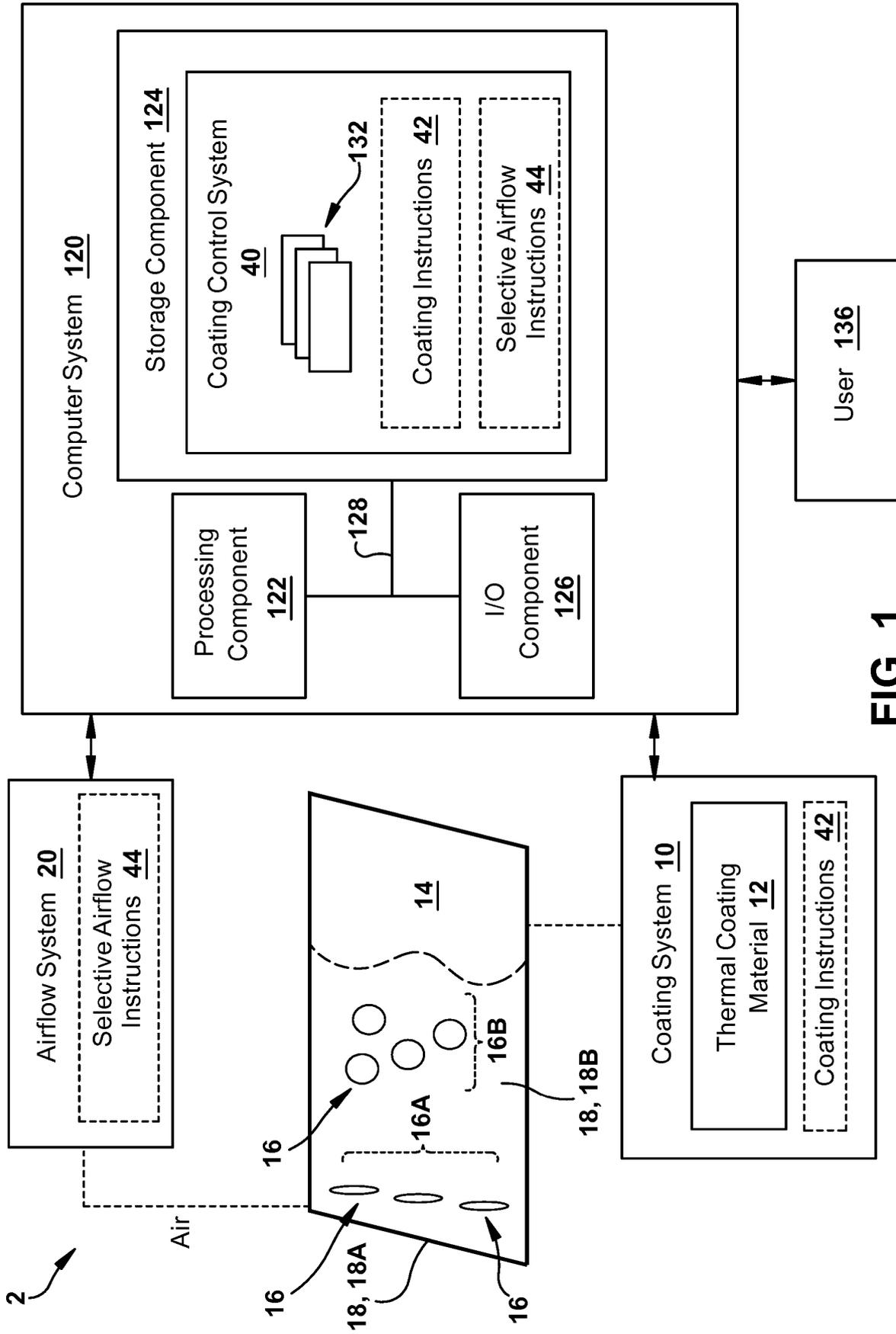
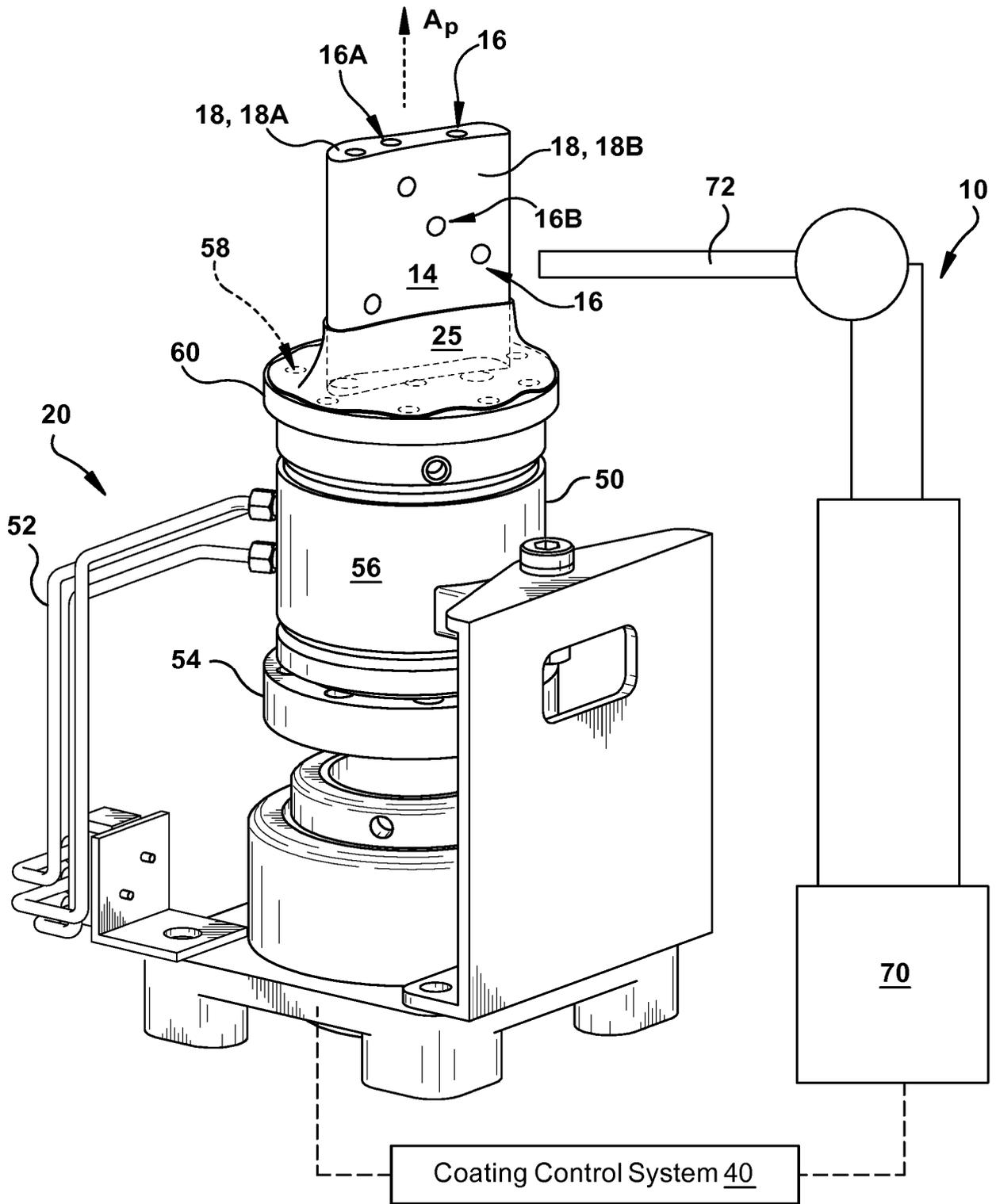
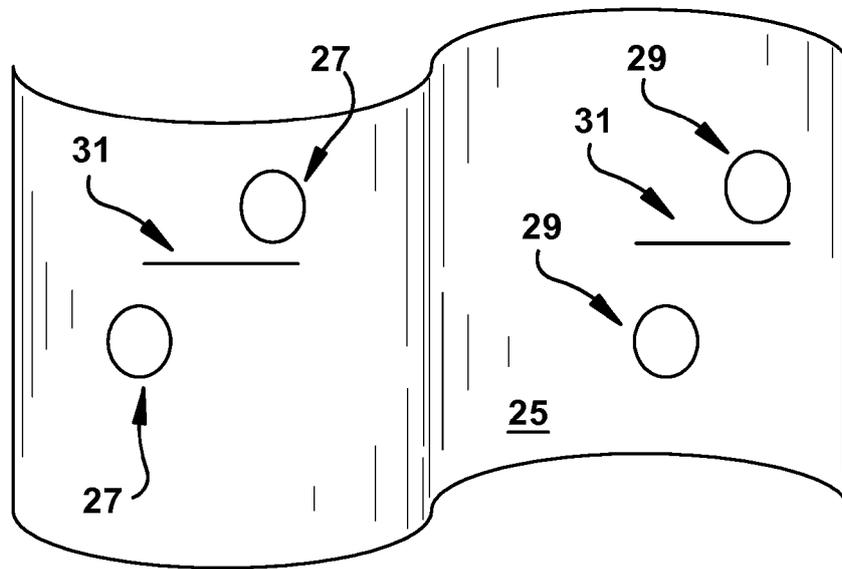


FIG. 1



**FIG. 2**



**FIG. 3**

**REFERENCES CITED IN THE DESCRIPTION**

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